

DESCRIPTION

METHOD FOR RECYCLING ABRASIVE FROM USED CERIUM OXIDE BASED ABRASIVE FOR GLASS CONTAINING FLOCCULANT

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FIELD OF THE INVENTION

[0001] The present invention relates to a method for recycling an abrasive from a used cerium oxide based abrasive for glass containing a flocculant.

10 BACKGROUND ART

[0002] A cerium oxide based abrasive for glass has been industrially widely used in various glass polishing processes due to its chemical polishing effect derived from its chemical composition. Conventionally, because of the price and supply condition of a cerium oxide based abrasive, the used slurry containing polished glass debris after the abrasive is used in polishing glass has generally been subjected to a process, such as solid-liquid separation, and then disposed of. However, a change of the social environment in recent years causes the supply of the abrasive to be unstable and a rise in the price, and, in such a situation, there are important tasks to be achieved including a reduction of the amount of the abrasive used in the glass polishing process, a recycling of an abrasive from the used abrasive, and the development of a new source for abrasive.

[0003] As a method for recycling the material from the used abrasive, a method has been known in which the abrasive is separated from the deposit of the used abrasive slurry utilizing a density difference to remove the material polished in the prior polishing process (patent document 1).

[0004] A method using a flocculant for promoting the flocculation of the abrasive has been proposed (patent document 2).

[0005] A technique has been proposed in which, for causing the used abrasive slurry to have good condition for dispersion, the used abrasive slurry is adjusted to alkaline condition and changed in the zeta potential, and the abrasive is recovered by centrifugal separation (patent document 3).

[0006] Further, a method has been proposed in which the used abrasive slurry is treated with an acid (patent document 4).

35 PRIOR ART REFERENCES

Patent Documents

[0007] Patent document 1: Japanese Laid-open Patent [Kokai] Publication No. 2005-14187

Patent document 2: Japanese Laid-open Patent [Kokai] Publication No. Hei 9-327603

5 Patent document 3: Japanese Laid-open Patent [Kokai] Publication No. 2002-28662

Patent document 4: Japanese Laid-open Patent [Kokai] Publication No. 2007-276055

10 SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0008] However, in the method of patent document 1, it is considered that a prolonged period of time is required to deposit the abrasive, and that the investment for the recycle plant is increased. In the case of the abrasive waste containing a flocculant, the glass
15 component, flocculant, and abrasive are crosslinked by the flocculant and hence they are difficult to separate from each other, and thus it is considered that the recycling cannot be carried out by this method. Further, it is disclosed that the recycled abrasive does not perform polishing function equivalent to that of an unused new abrasive unless it is calcined.

20 The flocculant of patent document 2 is for use in the disposal of polishing wastewater and causes flocculation of the suspension in wastewater for the disposal, and the resultant flocculate contains both the abrasive component and the polished glass debris. Therefore, this flocculant is not suitable for recycling of the abrasive.

Further, the present inventors made an attempt to recycle an abrasive by the
25 method using an alkali described in patent document 3. As a result, it has been found that the obtained recycled abrasive still contains SiO₂ as a polished glass debris and the aluminum component as a flocculant component, so that the recycled abrasive cannot perform polishing function equivalent to that of an unused new abrasive.

Furthermore, in the method of patent document 4 using a treatment with an
30 acid, a recycled abrasive having polishing function equivalent to that of an unused new abrasive cannot be obtained unless the recycled abrasive is calcined (Example 1 of patent document 4). The present inventors made an attempt to recycle an abrasive by the method using a treatment with an acid described in patent document 4. As a result, they have found the following. When the acid treatment solution has a pH of 1, the
35 polishing rate is lowered, although the reason for this is unknown. When the acid treatment solution has a pH of 2, the polishing rate becomes unsatisfactory because of

the polished glass debris remaining in a large amount. When the acid treatment solution has a pH of 3, the polishing rate becomes poor because of the glass component and flocculant component remaining in a large amount. On the other hand, the present inventors made an attempt to adjust the used abrasive slurry to a predetermined alkali concentration and then adjust the pH to 1 to 3. As a result, they have found that the polishing rate is improved, as compared to that obtained when only the above-mentioned acid treatment is conducted.

[0009] It is an object of the present invention to provide a method for recycling an abrasive, wherein the removal rate for both the polished glass debris (silicon component) and the flocculant component in recycling a used abrasive is increased, as compared to that in the case of merely conducting an acid treatment, and wherein the obtained recycled abrasive has an polishing performance equivalent to that of a new abrasive.

Means to Solve the Problems

[0010] The present inventors have found that, by controlling the pH of a slurry of a used cerium oxide based abrasive for glass containing a flocculant to be within predetermined ranges in two stages, an abrasive containing almost no glass component and flocculant and having polishing performance equivalent to that of an unused new abrasive can be easily recovered, and the present invention has been completed.

[0011] Specifically, in the first pH adjustment, the pH is adjusted to an alkaline range. It is considered that, in this step, with respect to the polishing component including molecular glass (SiO_2) formed by chemically polishing the surface of the used abrasive particles by the glass polishing process, the flocculant component, and the abrasive, the dispersibility of each component is improved. In the subsequent second pH adjustment, the pH is adjusted to an acidic range. It is considered that, in this step, the abrasive component is settled to rapidly, that makes it possible to separate the abrasive from the polished glass particle and flocculant. By merely adjusting the pH to an alkaline range, both the flocculant and polished glass particle cannot be removed.

Further, by merely lowering the pH, the obtained effect is poor, as compared to that obtained when the pH is adjusted in two stages.

[0012] The present invention is as follows.

[0013] 1. A method for recycling an abrasive from a used cerium oxide based abrasive for glass containing a flocculant, characterized in that the method comprises the steps of: adjusting the pH of a slurry of the used cerium oxide based abrasive for glass containing a flocculant to be within the range of from 10.0 to 14.0, and then adjusting

the pH of the slurry to be within the range of from 1.0 to 3.0.

[0014] 2. The method for recycling an abrasive according to claim 1, characterized in that a hydroxide or a carbonate of an alkali metal or an alkaline earth metal is used as a pH adjustor for adjusting the pH to be within the range of from 10 to 14.

5 [0015] 3. The method for recycling an abrasive according to claim 1 or 2, characterized in that hydrochloric acid, nitric acid, phosphoric acid, or sulfuric acid is used as a pH adjustor for adjusting the pH to be within the range of from 1.0 to 3.0.

[0016] 4. The method for recycling an abrasive according to any one of claims 1 to 3, characterized in that sodium hydroxide is used as a pH adjustor for adjusting the pH to be within the range of from 10 to 14.

10 [0017] 5. The method for recycling an abrasive according to any one of claims 1 to 4, characterized in that hydrochloric acid is used as a pH adjustor for adjusting the pH to be within the range of from 1.0 to 3.0.

[0018] 6. A recycled abrasive for glass, which is obtained by the method for recycling an abrasive according to any one of claims 1 to 5.

Effect of the Invention

[0019] By the present invention, there can be provided a method for easily recycling an abrasive having polishing performance equivalent to that of an unused new abrasive from a used cerium oxide based abrasive for glass containing a flocculant at high removal rate for the silicon component and flocculant component.

MODE FOR CARRYING OUT THE INVENTION

[0020] The present invention is directed to a method for recycling an abrasive from a used cerium oxide based abrasive for glass containing a flocculant component. As a cerium oxide based abrasive for glass is used, the polishing performance becomes poor. Therefore, the abrasive is disposed of at a certain point in time. In the disposal of the abrasive, a flocculant is added to the slurry of the used cerium oxide based abrasive for glass to cause flocculation of the abrasive component, and the resultant flocculate is dehydrated, and the abrasive is disposed of in the form of such a dehydrated cake. The present invention is directed to a method for recycling an abrasive from a used cerium oxide based abrasive for glass containing a flocculant, which has conventionally been disposed of in the form of a slurry or cake.

[0021] The used cerium oxide based abrasive for glass containing a flocculant is not particularly limited as long as it is generated when a cerium oxide based abrasive for glass is used in polishing glass and it contains a flocculant.

[0022] The flocculants contained in the used abrasive for glass includes polyaluminum chloride, iron chloride, aluminum sulfate, and silica, and particularly, is polyaluminum chloride, aluminum sulfate, and silica.

[0023] The material, form, size, and structure of the cerium oxide based abrasive are not particularly limited, and can individually be appropriately selected according to the object.

[0024] The material for the cerium oxide based abrasive is not particularly limited, and can be appropriately selected according to the object. For example, it is included a cerium oxide based abrasive containing at least cerium oxide and optionally further containing lanthanum oxide, praseodymium oxide and the like.

[0025] The average particle size of the cerium oxide based abrasive is not particularly limited, and can be appropriately selected according to the object, and is, for example, 0.5 to 10 μm . Here, the average particle size can be measured by, for example, a laser diffraction type particle size distribution measuring system (as an example, SALD2000A, manufactured by Shimadzu Corporation).

[0026] Rare earth elements contained in the cerium oxide based abrasive, such as cerium, lanthanum, and praseodymium, are valuable resources and elements desired to be reused by recovering them.

[0027] Abrasive waste contains at least a cerium oxide based abrasive and polished glass debris, and optionally further contains another component, such as a flocculant. The abrasive waste is representatively in a cake form.

[0028] The abrasive waste in a cake form is obtained by, for example, adding a flocculant to a mixture slurry containing both the used cerium oxide based abrasive and polished glass debris to cause flocculation of the cerium oxide based abrasive, and then reducing or removing water from the resultant flocculate by, for example, solid-liquid separation means to obtain a wet cake form (dehydrated cake form), or then drying the cake. The water content of the abrasive waste is generally about 30 % by mass to 60 % by mass.

[0029] Here, the term “cake” means a solid material containing water in a compressed state by, for example, pressing by means of a filtration apparatus, and the term “slurry” means a solid material in a liquid state or a mud state in which the solid material is dispersed in a liquid, such as water.

[0030] The state (size) of the abrasive waste is not particularly limited, and may be a size possible to be fed into a milling machine (generally, about several cm or less).

[0031] The polished glass debris are polished debris generated when polishing a glass material, such as a glass disc, a crystal wafer, or a liquid crystal panel, using a cerium

oxide based abrasive.

[0032] It is considered that polishing the above-mentioned glass material using a cerium oxide based abrasive is different from physically or mechanically polishing a material using a general abrasive (for example, aluminum oxide), and the silicon component of the glass material causes a chemical reaction when the cerium oxide based abrasive is in contact with the glass material, and the silicon component is removed in a size at an atomic level and attached to the cerium oxide to achieve polishing. For this reason, the resultant polished glass debris have an even smaller size than that of the cerium oxide based abrasive. Further, in the abrasive waste, the polished glass debris are attached mainly to the cerium oxide based abrasive.

[0033] When the used abrasive is in the form of a cake, the recycling method of the present invention comprises the step of adding water to the cake to form a slurry. In this case, a milling treatment is preferably performed using, for example, a ball mill.

[0034] The milling treatment is not particularly limited as long as it is a step in which the abrasive waste in a cake form containing a cerium oxide based abrasive and polished glass debris is mixed with, for example, water and milled by means of a milling machine, and the milling treatment can be appropriately selected according to the object. The abrasive waste is preferably mixed with any one of an aqueous acid solution and an aqueous alkali solution. The term "milling" means pulverization of the cerium oxide based abrasive in a flocculate state in the abrasive waste.

[0035] The milling machine is not particularly limited, and can be appropriately selected according to the object. The milling machine includes a media mill, a roll mill, a strong agitation type agitator, a line mixer, a colloid mill and the like.

[0036] The media mill is not particularly limited as long as it is an apparatus in which balls or beads (hereinafter, frequently referred to as "media") are placed in a container and stirred together with a solid or a liquid, and can be appropriately selected according to the object.

[0037] The media mill includes a paint shaker in which a closed container is mechanically shaken to strongly stir media, a ball mill in which a closed container is mechanically rotated to stir media, an attritor and a sand mill, in which a stirrer (of which form varies depending on the apparatus manufacturer, for example, a stirrer having a number of rods fitted to a rotating shaft, or a stirrer having multi-stage discs fitted to a rotating shaft) is placed in a container having a cover and rotated to strongly stir media, a bead mill in which a closed container has therein a rotating shaft having a number of discs (called agitator discs) fitted thereto and the rotating shaft is rotated to strongly stir media and the like.

[0038] The name of the media mill apparatus frequently varies depending on the production manufacturer, but any apparatus has a feature that a solid or a liquid can be strongly milled by the force of collision of the media stirred together with the solid or liquid. There can be used the above apparatuses which have been widely used in, for example, grinding, dispersing, or mixing an inorganic material, or kneading or dispersing a paint pigment.

[0039] The material for the media is not particularly limited, and can be appropriately selected according to the object. Examples of the materials for the media include soda glass, alumina, zirconia, and Teflon (registered trademark).

[0040] The size of the media is not particularly limited, and can be appropriately selected according to the object. A diameter of the media is preferably 5 to 30 mm, more preferably 10 to 20 mm.

[0041] The roll mills include, for example, a two-roll mill and a three-roll mill. Of these, preferred is a three-roll mill in view of the milling power. The operating condition for the three-roll mill is not particularly limited, and can be appropriately selected according to the object. Preferred are conditions such that the rotational speed of the front roll is 50 rpm to 200 rpm and the front roll:middle roll:back roll rotational ratio is 1.0:1.5:5.0 to 1.0:3.0:8.0.

[0042] The above-mentioned colloid mill is a mill in which a fixed disc or a fixed ring is placed extremely close to a disc or rotor rotating at a high speed and an object is charged into the narrow gap between them and milled.

[0043] The operating time for the milling machine, i.e., milling time, is not particularly limited, and can be appropriately selected according to the object. For example, when the strength of the cake is high due to, for example, a high flocculant content of the abrasive waste or a low water content of the cake, the increase of the milling time can improve the effect of milling. Appropriate conditions for the milling vary depending on the composition of the abrasive waste or the state of the cake.

However, when the milling time is too short, the milling may be unsatisfactory so that the acid and alkali treatments cannot affect the inside of the solid material kept in a flocculate state, making it difficult to obtain a desired composition and particle size of the recycled abrasive (recovered material). When the milling time is too long, the primary particles formed after the milling may be ground to an excess extent, causing the particle size of the recycled abrasive (recovered material) to be unsuitable for the object of the use of recycling, for example, an abrasive. When the milling time is in a preferred range, there is obtained an advantage at the same time not only in that the abrasive can be uniformly milled into primary particles to effectively separate the solid

material to be recovered and the component to be removed from each other, but also in that the particles having a particle size suitable for an abrasive and other uses without grinding the abrasive particles to an excess extent.

[0044] The average particle size of the milled material obtained by the milling treatment is not particularly limited, and can be appropriately selected according to the object, and includes, for example, 0.5 μm to 10 μm . Here, the average particle size can be measured by, for example, a laser diffraction type particle size distribution measuring system (as an example, SALD2000A, manufactured by Shimadzu Corporation).

[0045] The recycling method of the present invention comprises the steps of: adjusting the pH of a slurry of the used cerium oxide based abrasive for glass containing a flocculant to be within the range of from 10.0 to 14.0, and then adjusting the pH of the slurry to be within the range of from 1.0 to 3.0.

[0046] In the step of adjusting the pH to be within the range of from 10.0 to 14.0, the pH is preferably 10.0 to 13.5, more preferably 12.0 to 13.5. The pH of the slurry is adjusted by adding an alkali to the slurry. The alkali includes hydroxides and carbonates of an alkali metal or an alkaline earth metal, such as sodium hydroxide, potassium hydroxide, sodium carbonate, and potassium carbonate. As the alkali, sodium hydroxide is preferred.

[0047] In the step of adjusting the pH of the slurry to be within the range of from 1.0 to 3.0, the pH value is preferably 1.0 to 2.5, more preferably 1.0 to 2.0. The pH adjustment is performed by adding an inorganic or organic acid to the slurry, preferably by adding an inorganic acid. The inorganic acid includes hydrochloric acid, nitric acid, phosphoric acid, and sulfuric acid. Hydrochloric acid is especially preferred.

The organic acid includes formic acid and acetic acid. Acids may be used in combination of two or more acids.

[0048] The combination of the pH values in two stages of the pH adjustment is preferably a combination of 10.0 to 14.0 and 1.0 to 3.0, especially preferably a combination of 10.0 to 13.5 and 1.0 to 2.5, most preferably a combination of 12.0 to 13.5 and 1.0 to 2.0.

[0049] The recycling method of the present invention can further comprise the steps of: recovering an abrasive from the slurry having pH adjusted in two stages; and washing, drying, and grinding the recovered abrasive.

[0050] The step of recovering an abrasive from the slurry is a step in which an abrasive is separated from the slurry having pH adjusted in two stages. As a method for separation, for example, a settling separation method, a centrifugal separation

method, or a filtration method can be employed.

[0051] The step of washing, drying, and grinding the recovered abrasive is a step in which an acid component attached onto the recovered abrasive, such as hydrochloric acid, is removed by washing with, for example., water, and the washed abrasive is dried using a general dryer, and then ground by a general grinding method. For example, the above-mentioned milling treatment may be conducted.

[0052] The recycled abrasive for glass obtained by the method of the present invention has a high removal rate for the silicon component and aluminum component, and has abrasive performance equivalent to that of an unused new abrasive.

[0053] The state of the recycled abrasive for glass is not particularly limited, and can be appropriately selected according to the object. The state of the recycled abrasive includes, for example, dry powder, a water-containing cake, and a slurry. In the process or company using the cerium oxide based abrasive, when it is desired that the recycled abrasive is in a state of dry powder, dehydration and drying are performed in the recovery method so that the recovered material is obtained in a state of dry powder, and the recovered material can be provided as a dry powder. When it is desired that the recycled abrasive is in a state of being dispersed in water as used in a polishing process, the recovered material is obtained in a state of a slurry having an appropriate pulp concentration, and thus the dehydration and drying steps can be omitted and the recovered material can be obtained at a low cost.

EXAMPLES

[0054] The present invention will be described with reference to the following Examples.

[0055] (Example 1)

Using a used cerium oxide based abrasive for glass containing a flocculant {waste in the form of a dehydrated cake recovered using a flocculant (polyaluminum chloride) for reducing the volume of the used slurry comprised mainly of cerium oxide discharged from a glass polishing process} as a raw material, the following test was conducted.

[0056] 200 g (dry weight) of the dehydrated cake of a used cerium oxide based abrasive for glass containing a flocculant was placed in a magnetic pot (ball mill, manufactured by AS ONE Corporation; volume: 2,000 ml), and 1,000 ml of water and 5 kg of zirconia balls having a diameter of 10 mm were charged into the pot. The magnetic pot was rotated at a rotational speed of 50 rpm for 10 minutes to grind the dehydrated cake.

[0057] Then, the contents of the magnetic pot were passed through a sieve having a sieve opening of 5 mm to separate the zirconia balls and the ground abrasive from each other, obtaining a slurry of the used cerium oxide based abrasive for glass containing a flocculant.

5 [0058] 500 ml of the obtained slurry of the abrasive was placed in a glass beaker having a volume of 1 L, and stirred at 250 rpm using a stirrer. As the first pH adjustment, 25% sodium hydroxide was added to the slurry to adjust the pH to 13.5. The slurry was stirred under this condition for 5 minutes.

10 [0059] Then, as the second pH adjustment, 35% hydrochloric acid was added to the slurry to adjust the pH to 1, and the resultant slurry was stirred for 10 minutes. Then, using a centrifugal separator (manufactured by Beckman Coulter, Inc.) at 3,000 rpm, the slurry was separated into a supernatant phase and a solid material concentrated phase. In this instance, the flocculant component and polished glass debris as impurities are in the form of finely divided particles or are dissolved, and therefore they are recovered as
15 a supernatant, and the abrasive is recovered as a solid material.

[0060] Then, an operation for the washing of the solid material recovered by centrifugal separation was performed. An operation for the washing with water was made as follows. The supernatant obtained after the centrifugal separation was discarded, and 400 ml of water was added to the settling solid material and the solid
20 material was dispersed in the water, and the resultant mixture was further subjected to centrifugal separation, and the resultant supernatant was discarded. This washing operation was repeated twice.

[0061] The recovered solid material was dried at a temperature of 105°C for 12 hours, and the results of compositional analysis of the obtained recovered material (recycled product from the used abrasive) and the raw material for test are shown in Table 1.
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[0062] (Examples 2 to 8)

Substantially the same operation as in Example 1 was performed, except that the first and second pH adjustments were made as shown in Table 1, to obtain recovered materials. The results of compositional analysis of the obtained recovered materials
30 are shown in Table 1.

[0063] (Analysis Example 1)

With respect to each of the obtained recycled abrasives, a compositional analysis was conducted using a fluorescent X-ray analyzer (Super mini, manufactured by Rigaku Corporation). The results are shown in Table 1. The composition is
35 indicated in terms of an oxide.

[0064] [Table 1]

	pH		Composition (wt%)						
	First adjustment	Second adjustment	TREO	Abrasive component				Glass component	Flocculant component
				CeO ₂	La ₂ O ₃	Pr ₆ O ₁₁	Nd ₂ O ₃	SiO ₂	Al ₂ O ₃
Virgin product	—	—	97.2	55.0	34.7	2.69	4.79	0.14	0.20
Raw material for recycling (waste)	—	—	71.83	47.5	21.5	2.83	N.D	11.70	12.80
Example 1	13.5	1	95.2	64.1	27.9	3.16	N.D	0.41	0.22
Example 2	12	1	95.4	62.7	28.9	3.84	N.D	0.55	0.24
Example 3	10	1	95.3	62.8	29.0	3.54	N.D	0.90	0.22
Comparative Example 1	Not adjusted (7)	1	94.0	62.0	28.1	3.44	0.42	1.34	0.33
Example 4	13.5	2	92.1	60.3	28.7	3.08	N.D	2.32	0.57
Example 5	12	2	94.5	63.2	27.6	3.72	N.D	1.56	0.78
Example 6	10	2	93.3	61.7	28.1	3.54	N.D	1.93	0.92
Comparative Example 2	Not adjusted (7)	2	89.9	59.7	26.7	3.46	N.D	5.76	1.07
Example 7	13.5	3	85.8	57.3	25.5	3.02	N.D	6.15	3.05
Example 8	12	3	92.2	60.90	27.10	3.65	0.57	4.56	2.08
Comparative Example 3	Not adjusted (7)	3	77.3	51.2	23.0	3.11	N.D	11.90	9.05
Comparative Example 4	Not adjusted (7)	7	55.0	35.8	17.2	1.95	N.D	12.90	16.50
Comparative Example 5	Not adjusted (7)	12	70.3	46.4	21.1	2.84	N.D	12.20	11.40

[0065] (Comparative Example 1)

Substantially the same treatment as in Test 1 of Example 1 was performed, except that the first pH adjustment using sodium hydroxide was not made, and the composition of the obtained recovered material is shown in Table 1. The composition is indicated in terms of an oxide.

[0066] The results have confirmed that, by controlling the pH of the used slurry to be within predetermined ranges in two stages, SiO₂ that is a polished glass debris and the aluminum component that is a flocculant component can be more effectively removed.

With respect to the effect of removing the polished glass debris and flocculant component, in each case where the final pH (second adjustment value) is 1, 2, or 3, the Si amount and Al amount were reduced when the pH was first increased, as compared to those amounts when the pH was not increased.

[0067] (Comparative Examples 2 to 5)

Substantially the same operation as in Comparative Example 1 was performed, except that the first pH adjustment was not made and the second pH adjustment was made as shown in Table 1, to obtain recovered materials. The results of compositional analysis of the obtained recovered materials are shown in Table 1.

5 [0068] (Analysis Example 2)

Using the recycled abrasive prepared using the method in Example 2, an evaluation test for polishing performance for glass was conducted.

[0069] As an object to be polished, white sheet glass having a diameter of 30 mm and a thickness of 5 mm was used. A test method is as follows.

10 [0070] 10 L of a slurry having a recycled abrasive concentration of 10 g/L was first prepared. 10 L of the slurry was charged into a glass polishing machine (Oscar type polishing machine), and 6 sheets of the above-mentioned glass were polished under conditions at a pressure of 2 kgf/cm² for 3 minutes per one sheet of the glass. The 6 sheets of the glass were continuously polished without replacing the slurry, and an
15 polishing rate (μm/min) was derived from the readout of the polished thickness amount of each glass, and an average of the 6 measurements was determined.

[0071] Further, a similar polishing test was conducted using an unused product (virgin product), and the virgin product and the recycled abrasives obtained in Examples were compared in the performance.

20 [0072] The results are shown in Table 2. The average polishing rate of the recycled abrasives was 1.5 μm/min, and the average polishing rate obtained by polishing the same glass using the virgin product was 1.5 μm/min. From the results, it is confirmed that the recycled abrasives have abrasive performance for glass equivalent to that of the virgin product. Further, the results of the 6 measurements of the polishing rate with
25 respect to the recycled abrasives and virgin product were subjected to F-test at a significance level of 5%, and the results are shown in Table 3. From the results, it is apparent that the variance ratio is smaller than the F boundary value, which indicates that no significant difference is recognized. Further, with respect to the appearance of the surface, the state of scorching, and the roughness of the surface of the polished
30 glass, there was no difference between the recycled abrasives and the virgin product.

[0073] [Table 2]

Comparison of polishing rate		
Number of surface	Recycled abrasive recovered by method in Example 2	virgin product
Average polishing rate (μm/min)	1.50	1.50
Standard deviation	0.35	0.18
Standard error	0.14	0.07

[0074] [Table 3]

Results of F-test for polishing rate of recycled product and virgin product		
	Recycled abrasive recovered by method in Example 2	virgin product
Variance	1.3	0.3
Variance ratio observed	4.33	
P ($F \leq f$), One side	0.09	
F boundary value, One side	6.39	

INDUSTRIAL APPLICABILITY

- 5 [0075] By the present invention, an abrasive having polishing performance equivalent to that of an unused new abrasive can be recycled from a used cerium oxide based abrasive for glass containing a flocculant by an easy method at high removal rate for the silicon component and flocculant component. Therefore, the present invention is
- 10 industrially useful also from an economical point of view and from the viewpoint of protection of the environment.

CLAIMS

1. A method for recycling an abrasive from a used cerium oxide based abrasive for glass containing a flocculant, characterized in that the method comprises the steps
5 of: adjusting the pH of a slurry of the used cerium oxide based abrasive for glass containing a flocculant to be within the range of from 10.0 to 14.0, and then adjusting the pH of the slurry to be within the range of from 1.0 to 3.0.
2. The method for recycling an abrasive according to claim 1, characterized in that a hydroxide or a carbonate of an alkali metal or an alkaline earth metal is used as a
10 pH adjustor for adjusting the pH to be within the range of from 10 to 14.
3. The method for recycling an abrasive according to claim 1 or 2, characterized in that hydrochloric acid, nitric acid, phosphoric acid, or sulfuric acid is used as a pH adjustor for adjusting the pH to be within the range of from 1.0 to 3.0.
4. The method for recycling an abrasive according to any one of claims 1 to 3,
15 characterized in that sodium hydroxide is used as a pH adjustor for adjusting the pH to be within the range of from 10 to 14.
5. The method for recycling an abrasive according to any one of claims 1 to 4, characterized in that hydrochloric acid is used as a pH adjustor for adjusting the pH to be within the range of from 1.0 to 3.0.
- 20 6. A recycled abrasive for glass, which is obtained by the method for recycling an abrasive according to any one of claims 1 to 5.